

Business analysis of Invasive Alien Species management registration by Belgian actors

Version 2



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RIPARIAS

Reaching Integrated and Prompt Action
in Response to Invasive Alien Species

Beneficiaries responsible in the implementation of action A.2.1:

Main action responsible: EV INBO

EV INBO will coordinate business analysis and software development for management registration and reporting (A.2.1,A.2.2). FLAGEW-INBO will bring in IAS management expertise and will contact, discuss and negotiate with management actors where needed (A.2.1, A.2.2.). SPWARNE and BE will share internal workflows and management reporting and management data flow (A.2.1, A.2.2).

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Introduction

The **Regulation (EU) 1143/2014 on invasive alien species (IAS)** requires Member States of the European Union (EU) to report on management actions performed on Union List species. Field management actions should therefore be logged and described using standardized and quantifiable variables. This requires standardized information on the type of management methods used (mechanical, chemical, other), the management effort, cost, effectiveness and the impact of the performed management on other biota or the environment. Yet, currently, no general standardized registration or reporting system for IAS management actions is available in Belgium.

Within LIFE RIPARIAS, there is a need for one or more field management registration systems that is fit for a variety of actors and species. Such a system should capture sufficient data to allow the evaluation of the cost-effectiveness of management actions and to perform the reporting to the EU for the Regulation.

The purpose of this business analysis is to explore and describe current IAS management registration systems, to outline the requirements of field managers and to identify a scenario for efficient registration of management actions performed during the LIFE RIPARIAS project. In 2022, we surveyed LIFE RIPARIAS partners as well as a range of other actors active in IAS management (regions, provinces, municipalities, local authorities, NGOs). **Part I** of this business analysis gives an overview of the different field management registration methods and tools used within the LIFE RIPARIAS study area. **Part II** describes the needs of field managers towards registration of IAS management methods and **Part III** compares field management registration software that are available on the market. In **Part IV**, we explore different scenarios for registering and reporting management data during the LIFE RIPARIAS project.

Within this business analysis, registration refers to the recording of a management action in the field, while reporting points to the production and delivery of the standard data forms to the European Commission.

Methodology

Part I – Current state of field management registration

We interviewed field managers on their registration methods and tools using a Google Spreadsheet including 32 questions (hereafter referred to as the questionnaire). This structured the interviews and facilitated analyses and comparison. A first version of the questionnaire was drafted by the Research Institute for Nature and Forest (INBO) in November 2021 and reviewed internally in December 2021. It included six main sections:

- General information: organization, purpose of field management actions
- Field management scope: questions related to the taxonomic scope of the target species, geographical and temporal scope of the management actions
- Content and structure: questions related to the registered data per management action
- Methods and technology: questions related to the technology used, data storage and data flow
- Standards and sharing: questions related to the sharing conditions, frequency of publication and data standards used
- Roadmap to improved field management registration system: questions related to experiences with current registration system, alternative tools considered and suggestions for improvement

The questionnaire was sent out to the following IAS field managers (LIFE RIPARIAS partners are marked with *):

- Agency for Nature and Forest *
- Bruxelles Environnement *
- Contrats de Rivières (CR Senne, CR Dendre, CR Dyle-Gette) *
- Department Integral Water Policy Service of the province - East Flanders
- Flanders Environment Agency *
- Flemish Waterways
- Rato VZW
- Regional landscape Schelde – Durme
- Walloon Research Department of Natural and Agricultural Areas *

From December 2021 to May 2022, we organized several interviews between INBO and the field managers to complete the questionnaire ([questionnaire results](#)). In February - March 2024, all interviewed managers were contacted again to verify any new developments or changes. It is important to note that the organisations we interviewed only represent a selection of IAS management actors in Belgium. This selection was primarily based on the pertinence of the management performed for the scope of the RIPARIAS project (aquatic and riparian plants, crayfish), but also to cover a good range of different management reporting tools used in Belgium. There are, however, many more actors in the field of IAS management in Belgium e.g. provinces, municipalities, NGOs, social economy, businesses. There are also a range of non-RIPARIAS species under management for which reporting is performed (e.g. *Vespa velutina*, *Oxyura jamaicensis*, *Lithobates*

catesbeianus). These were left outside the scope of this exercise, although we expect the general principles also apply to these management programmes. In particular, the nature NGOs Natuurpunt and Natagora perform a lot of IAS management in their nature reserves therefore this represents a venue for future work.

Part II – Registration needs of field managers

From the general questionnaire it was clear that four partners showed interest in using a new field management registration tool, e.g. one that could be developed within LIFE RIPARIAS. These partners were offered a [second questionnaire](#) that focused on their specific needs and prioritization for registration. This second questionnaire included the following aspects:

- Features that are necessary to have
- Features that are nice to have
- Available budget within organization (during project and after)
- Prioritization of necessary features

This questionnaire was sent to the following LIFE RIPARIAS partners:

- Bruxelles Environnement (BE)
- Contrats de Rivières (Senne, Dendre, Dyle-Gette)
- Flanders Environment Agency (VMM), the department responsible for management of non-navigable 1st category rivers
- Walloon Research Department of Natural and Agricultural Areas (SPW - DEMNA)

In **Part II** of this business analysis common needs of field managers for registration on field management actions are discussed, based on the general questionnaire. Additionally, the specific needs (and their prioritization) of the managers that are interested in a new tool are examined.

Part III – Available software for field management registration

An online search on potential field management registration software was performed that resulted in a total of 15 different available software tools:

- Appsheet
- DIPLA
- Ecosystem
- Fieldmaps
- Fulcrum
- GBI beheersysteem
- gisib
- Visma | iAsset
- magpi
- REDCAp
- SurveyCTO

- Teamscope
- TenForce
- VertiGIS
- Wildnote

This information was collected early June 2022 from websites and during interviews with sales departments. These software tools are compared in a [summary table](#), based on the general list of necessary features for a field management registration tool generated in Part II. Language support and pricing are taken into account as well. All sales departments were offered the opportunity to revise the description of their software.

Part IV – Field management registration software for LIFE RIPARIAS

In this part, we identified the different scenarios for an optimized registration of management actions during the LIFE RIPARIAS project, using information from Part II and Part III as input. This scenarios were used as input for a [participative workshop](#) to assess the proposed scenario's together with the LIFE RIPARIAS partners. Following the selection of the best scenario, a public procurement process was initiated in September 2022, leading to the selection of iAsset as the most successful applicant.

Part I: Current state of field management registration

1. General overview

Purpose

The purpose of field management varies between partners included in this survey. A distinction can be made between partners performing general management of river systems (e.g. to restore constructions, improve water quality and biodiversity), IAS specific management or both (see table 1). Some partners only plan and evaluate actions that are performed by others (e.g. contractors), others perform actions, or do both. Some partners focus on aquatic systems (e.g. VMM, CR) whereas others also manage terrestrial systems (e.g. ANB, BE).

Table 1. Overview of management purpose. Throughout this text, we refer to field managers by their acronym.

Field manager	Acronym	Purpose
Agency for Nature and Forest	ANB	Registration, execution and planning of field management actions
Bruxelles Environment	BE	Improve biodiversity, manage invasive species
Contrats de Rivières Dendre	CR-Dendre	General river management (including IAS)
Contrats de Rivières Dyle-Gette	CR-Dyle	General river management (including IAS)
Contrats de Rivières Senne	CR-Senne	General river management (including IAS)
Department Integral Water Policy Service of the province - East Flanders	DIWPS- EF	Planning and evaluation of IAS management
Flanders Environment Agency – rat control team	VMM-rat	Rats (muskrat, coypu) and IAS (Chinese mitten crab, invasive plants, crayfish) management in and along rivers
Flanders Environment Agency - the department responsible for management of non-navigable 1st category water courses	VMM-water	River management, including IAS management in and along rivers
De Vlaamse Waterweg nv	DVW	General river management (including IAS)
Ecosystems (Interreg project)	EIP	Cross border management of muskrat
Rato VZW	Rato VZW	Management of pest species and IAS
Regionaal landschap Schelde-Durme	RLSD	General management of small landscape features and landscape management (including IAS)
Walloon Research Department of Natural and Agricultural	SPW-DEMNA	Improve biodiversity, manage IAS

Taxonomic scope

In Wallonia, IAS are being managed by SPW-DEMNA and CR since the start of the regional management plan in 2010. BE manages IAS within all public green spaces of the Brussels Region for which it is responsible since the enforcement of the 'Ordonnance Nature' in 2012. ANB has been registering management actions of IAS within areas under their supervision in Flanders since 2011. In Flanders, 1st category unnavigable watercourses are managed by VMM, 1st category navigable watercourses by DVW and 2nd category watercourses by the provinces. Partners focus either on animal species, plant species or a wide range of species (see table 2).

Table 2. Taxonomic and geographical scope

Partner	Taxonomic scope	Geographical scope
ANB	All species which are legally required to be managed, IAS managed in public forests and nature reserves, protected areas etc. Management actions using shooting for which hunting permits are needed (e.g. Chinese muntjac).	Flanders
BE	Invasive plants (land plants, shore plants and aquatic plants), waterbirds (i.e. <i>Alopochen aegyptiaca</i> and <i>Branta canadensis</i>), <i>Eriocheir sinensis</i> and <i>Trachemys scripta troostii</i>	Brussels
CR-Dendre	<i>Impatiens glandulifera</i> and <i>Heracleum mantegazzianum</i>	Dendre river basin
CR-Dyle	<i>Impatiens glandulifera</i> , <i>Heracleum mantegazzianum</i> , <i>Hydrocotyle ranunculoides</i>	Dyle-Gette sub- basin
CR-Senne	<i>Heracleum mantegazzianum</i> , <i>Impatiens glandulifera</i> , <i>Hydrocotyle ranunculoides</i>	Senne river basin
DIWPS- EF	Water-bound IAS	Flanders: unnavigable, 2 nd category watercourses
VMM-rat	<i>Rattus norvegicus</i> , <i>Myocastor coypus</i> , <i>Ondatra zibethicus</i> , <i>Hydrocotyle</i> , <i>Ludwigia</i> , <i>Myriophyllum</i> , <i>Eriocheir sinensis</i>	Flanders: all rivers
VMM-water	Riparian invasive species (e.g. <i>Impatiens glandulifera</i> , <i>Heracleum mantegazzianum</i>) and crabs	Flanders: unnavigable, 1 st category watercourses
DVW	<i>Eriocheir sinensis</i> , <i>Hydrocotyle ranunculoides</i> , <i>Myriophyllum aquaticum</i> , <i>Ludwigia grandiflora</i> , <i>Fallopia japonica</i> , <i>Impatiens glandulifera</i> and <i>Heracleum mantegazzianum</i>	Dikes and waterways of navigable watercourses in Flanders
EIP	<i>Ondatra zibethicus</i>	East Flanders, West Flanders, department Nord (France)
Rato VZW	7 invasive plant species, some pest species, 5 species of geese and <i>Neovison vison</i>	East Flanders (Geese: Flanders)
RLSD	IAS occurring in small landscape features (e.g. <i>Reynoutria japonica</i> or <i>Bambuseae</i>)	22 municipalities along Schelde and Durme
SPW- DEMNA	Wide range of species (<i>Vespa velutina</i> , invasive aquatic plants, <i>Branta canadensis</i> , <i>Ondatra zibethicus</i> , <i>Impatiens glandulifera</i> , <i>Heracleum mantegazzianum</i> , etc.)	Wallonia

Are all field management actions on IAS registered and why (not)?

To optimize reporting, all management actions should be registered by field managers covering all species of interest. Five organizations noted a (large) gap in or a lack of registration of management actions, whereas only four organizations highlighted that registration is regularly performed (see table 3). Rato vzw is the only organization claiming that all actions were registered.

Several reasons were reported that currently prevented field managers from performing management registration (see table 3):

- contractors have a different workflow and do not use the system provided by the organization
- contractors are not required to register their actions
- ad-hoc actions are not planned and thus easily forgotten to register
- depending on species knowledge of the field manager, not every IAS is recognized during field management
- field managers do not have the time to register

Table 3: efficiency of registration and possible reasons

Partner	Are all actions registered?	Possible reasons?
ANB	Often but 100% registration is impossible, especially of those actions not performed by ANB staff	
BE	No	-
CR-Dendre	Efficiency of registration unknown	-
CR-Dyle	No	Ad-hoc actions are not always registered
CR-Senne	Most	-
DIWPS- EF	Not applicable (only planning and evaluation)	Not applicable
VMM-rat	Most	Depending on the expertise of the field employee in invasive species, observations of extra species are registered and eventually managed.
VMM-water	No	Only visual inspection of management action, registration is not mandatory
DVW	No	-
EIP	unknown	
Rato VZW	Yes	Registration is mandatory
RLSD	Most	DIPLA not yet enrolled within entire organization
SPW-DEMNA	No, only recordings of <i>Heracleum mantegazzianum</i> and even these actions are not always registered.	Field managers do not take the time to register actions. Possibly as the current system is not compatible with mobile phones.

Registered information per field management action

The following elements should at least be recorded per field management action: **location**, **date** and **target species**. Most of the tools currently in use only support point locations. For the moment, two management registration tools allow the use of polygons (Rato vzw and ANB). Notably, partners which are transitioning to a new system are choosing for an option which also includes polygons (e.g. gisib, iAsset, Terraplan, VertiGIS). Sometimes only an address or municipality is recorded, not an exact location.

Information regarding the following elements is also registered:

- method (ANB, VMM-rat, CR, Rato vzw, SPW-DEMNA)
- impact (ANB, VMM-rat, CR, Rato vzw, SPW-DEMNA)
- non-target effect (VMM-rat)
- effort (ANB, CR, Rato vzw, SPW-DEMNA)
- evaluation / regrowth during follow-up
- name of the field executor (SPW-DEMNA, ANB)
- greenwaste outcome (SPW-DEMNA)
- specific features of trapped individuals (weight and sex) (VMM-rat)
- cost price (if fixed per m²) (DIWPS- EF)
- aftercare plan (DIWPS- EF)
- accessibility of area (DIWPS- EF)
- remark field

Table 4. Registered information on method, impact, non-target effect and effort per field management action. Only partners with a detailed registration system for management actions are included.

Partner	Method	Impact	Not-target effects	Effort
ANB	Mechanical, chemical (type, quantity, permission ID) or a combination	Percentage of cover/number of individuals removed	Not compulsory (free-text field)	Person hours, Person days
CR-Senne	Root out/ pulled out manually/ by machinery	Number of plants removed	No	Number of persons and total time
VMM-rat	Hand picking, rodenticides (type and quantity), trapping (type of trap)	Number of captured rats (weight and sex)	Bycatch	No
EIP	Action (observed, cathed or removed), material used (type of trap)	Number of catches and active traps or number of plants removed	No	No
Rato VZW	Action (observed, caught/removed or advise provided), material used (type of trap)	Number of trapped/observed animals, %m ² removal, regrowth	Not compulsory (free-text field)	Time registration included for plant trajectories

RLSD	Mechanical/handpicking	Tracing occupancy over time	No	Total time and material (for contractors only)
SPW-DEMNA	Root cutting, grazing, mechanically or defined more precisely (option for fill-in field)	Size of population (number of individuals) before removal and proportion removed (%)	No	Total person days

How are field management actions on IAS registered?

To streamline the exchange of information on management actions within an organization, a central system to register management actions is crucial.

Surprisingly, of the 13 organizations that were questioned, 4 highlighted that they do not have a registration system besides scattered information in emails or an offline diary. It is clear from the survey that either (see table 5):

- a central registration system is absent: actions are not structurally registered and are scattered within the organization (e.g. VMM-water, DVW)
- a central registration system is absent but data are collected on paper within an offline diary but not digitized (e.g. BE)
- a registration system is available but only for some species (e.g. SPW-DEMNA for *Heracleum*)
- a registration system is available for planning and evaluation only, data on field management actions are collected separately (in Word, Excel or QGIS) (e.g. CR)
- a registration system is available and allows registration of actions for a wide range of species (e.g. ANB and Rato vzw)

Those partners who have a field management registration tool, developed the software in-house (e.g. POBW, Rattenapp, Heracleum portal of SPW-DEMNA) or use existing field management software (e.g. Fulcrum, TenForce, gisib, iAsset, VertiGIS). In the field, registration is performed using a mobile app, a web app or on paper. For the moment, only the Ecosystem app allows offline registration of management actions. Also, some systems are not yet compatible with smartphones (POBW, Heracleum portal of SPW-DEMNA); partners transitioning to a new system see this as a necessary requirement. Data are centralized on a server of the organization (POBW, Department Integral Water Policy Service of the province - East Flanders, VMM – rattenapp), an external server (e.g. Ecosystem) or stored only locally on the laptop of the field manager (CR).

Table 5. Overview of field management registration tools and data flows used for field management registration

Partner	Central registration system	System contains actions	Used software	Description of dataflow
ANB	yes	yes	POBW (transitioning to Terraplan by TenForce)	Registration in the field on paper, later recorded in web app on desktop (not compatible with smartphones)
BE	No	-	-	Management actions of invasive alien species are only documented on paper by the field managers (within an offline diary)
CR-Dendre	Yes	No	Fulcrum: planning, QGIS: registration of actions, DEMNA-portal in case of <i>Heracleum mantegazzianum</i>	An observation in the field can immediately be recorded in the Fulcrum app. The field manager adds data in a QGIS project on desktop
CR-Dyle	No	-	ArcGIS, DEMNA-portal in case of <i>Heracleum mantegazzianum</i>	Observations in the field are registered on desktop at a later time by field manager
CR-Senne	Yes	No	Fulcrum: planning, Word or Excel: registration of actions, DEMNA-portal in case of <i>Heracleum mantegazzianum</i>	An observation in the field can immediately be recorded in the Fulcrum app. Notes are collected on paper in the field which are collected in word or Excel at a later time
DIWPS- EF	Yes	No	Currently: QGIS for planning and evaluation, in transition to gisib for invoicing	Notes are recorded on paper in the field and then transferred to a QGIS project when in the office
VMM-rat	Yes	Yes	Rattenapp	Data are recorded by field staff in their smartphone app and are synced twice a day to the central database on the VMM server.
VMM-water	No	-	-	Data on management actions are scattered (on paper or emails) within the organization and not centrally available
DVW	No	-	Currently none but transitioning to iAsset	Data on management actions are scattered (on paper or emails) within the organization and not centrally available
EIP	Yes	Yes	Ecosystem	Data recorded by field staff in their smartphone app and are synced with the central database on the server of Continuum
Rato	Yes	Yes	VertiGIS	Data are recorded in web application (compatible with smartphone)
RLSD	Yes	Yes	DIPLA	Data entry on PC or smartphone which is then uploaded to the DIPLA Server
SPW-DEMNA	Yes for <i>Heracleum mantegazzianum</i> , other species No	Yes	online registration system for <i>Heracleum mantegazzianum</i>	Data entry using web interface and synced with central database available online for registered people (extended rights for administrators, incl. data validation, edition, etc.)

Data standards and openness

Most of the interviewed partners do not share their data on management actions openly (yet). In most cases, field management data is visible for people within the organization or registered in the system. Sharing of these data outside the organization is often only done upon specific request. Recently, efforts have been made to publish several field management datasets as open data to the Global Biodiversity Information Facility (GBIF, table 6). These datasets are published as a [Darwin Core Archive](#), an international standard for compiling biodiversity data from varied sources. However, the Darwin Core standard does not capture all essential information to report on field management activities. In this framework, the development of a data exchange format for IAS and wildlife management data is crucial, see Part IV.

Table 6: Overview of openly published datasets with management data

partner	dataset title	link
DIWPS- EF	Targeted monitoring of fishes and crustacea by the Provincial Center of Environmental Research, Province East-Flanders, Belgium	https://doi.org/10.15468/ap9ejd
DIWPS- EF	Monitoring of invasive alien species by the Provincial Center of Environmental Research, Province East-Flanders, Belgium	https://doi.org/10.15468/29cgtt
RATO	RATO - daily operations commissioned by province East Flanders, Belgium	https://doi.org/10.15468/fw2rbx
VMM-rat	Rat control occurrences collected by VMM in Flanders, Belgium	https://doi.org/10.15468/wquzva
VMM-water	Inland water macroinvertebrates occurrences in Flanders, Belgium	https://doi.org/10.15468/8e9te4

2. Detailed description per partner

2.1. Agency of Nature and Forest (ANB)

We identified three different registration systems for ANB: Planning en opvolging beheerswerken (PBOW), TERRAPLAN, and Fieldmaps. Fieldmaps is an ArcGIS based system to register management actions for the LIFE DUNIAS project. As the LIFE DUNIAS project does not include any LIFE RIPARIAS species nor overlaps with the geographic scope of the project, it was not included in this overview. However, a detailed description of the application can be found in the [questionnaire results](#).

Planning en opvolging beheerwerken (POBW)

The Agency of Nature and Forest (ANB) is responsible for field management in Flemish (nature) areas under their supervision. This field management is diverse, ranging from maintenance of the infrastructure to managing IAS. Management actions are performed for all IAS which are subject to a dedicated policy or legal framework (*Reynoutria japonica*, *Heracleum mantegazzianum*, *Hydrocotyle ranunculoides*, *Prunus serotina*, *Ludwigia grandiflora*, *Ludwigia peploides*, *Robinia pseudoacacia*, *Berberis aquifolium*, *Myriophyllum aquaticum*, *Impatiens glandulifera*, *Rosa rugosa*, *Lagarosiphon major*, *Yucca* spp., *Sorbaria sorbifolia*, *Symphoricarpos albus*, *Solidago canadensis*, *Solidago gigantea*, *Prunus laurocerasus*, *Cotoneaster* spp., *Spiraea douglasii*, *Muntingia calabura*, *Trachemys scripta*, *Alopecurus aegyptiaca* and *Lithobates catesbeianus*). Management actions are recorded in POBW ('Planning en opvolging beheerwerken') since 2011. Management registration is strongly encouraged within the organization. Still, "100% registration of every single management action has proven to be impossible, especially if these actions are not performed by ANB staff". POBW was originally designed to be used for registration by ANB staff and contractors. However, as third parties generally use a different workflow, they do not register their actions within the system.

The registration system focuses on the following four questions: what, where, when and by whom. When registering a management action, first the main category and subcategory are defined (e.g. main category: management of infrastructure, subcategory: maintenance). Depending on the selected categories, a tab called 'specific data' might appear to describe extra details about the management method (e.g. type of pesticide or machinery used). Action method is subdivided in three categories: mechanical, chemical or a combination. Depending on the domain of the managed species (plant, animal or *Prunus serotina*) the option to describe methodology differs. A free input field to describe the method is always available. In case of chemical treatment, the following information is required: chemical substance, quantity and authorization ID. Management impact is described as the percentage of cover removed for plants and number of individuals removed for animals. Non-target effects of management are not compulsory but might be mentioned as a remark. To define the location of the management action, the name of the management unit can be selected from a list or the corresponding polygon can be selected on a map. All management units for which ANB is responsible are predefined within the system as fixed polygons. Per action, multiple management units can be selected if they belong to the same domain. Depending on whether it is ANB personnel or a sub-contractor who performed the management action, different tabs are used to define the timing of the work (start and end date), field executor and work effort (in man hours or man days). The names of the field executors are only requested from ANB personnel, whereas the

number of the contract and name of subcontractor are only requested from subcontractors. The field management registration tool also has the option to generate a report in which total man days are summed per management category, per month and per management unit. 'POBW' is an in-house built web application which is not openly available. The database is stored on ANB servers. As the application is not compatible with smartphones, a form needs to be filled in on paper in the field, which is later digitized on the desktop. On average, the time lag between a management action in the field and data availability within the organization is 1 month. Anyone within ANB has access to the data. Outside the organization, the data is available upon request. There is overall a good satisfaction about POBW, but its user-friendliness could be improved and the lack of a mobile app is a disadvantage.

TERRAPLAN

Currently, ANB is transitioning from 'POBW' to 'Terraplan', a TenForce-based field management registration tool. Terraplan will allow better planning of field management actions (extended planning options compared to POBW) and direct data entry in the field as a mobile app is included. The first pilot projects are running in Terraplan to test the system. Probably, it will be enrolled within the entire organization in 2025. In Terraplan, locations might refer to predefined polygons, lines and points or points that are created by the user. In addition to long-term management, short-term management (such as after-care) will also be registered and planned in the system. Details about methodology, management impact and effort still need to be determined. ANB did not express interest to adopt other software during the LIFE RIPARIAS project.

2.2. Brussels Environment (BE)

Brussels Environment manages all public green spaces of the Brussels-Capital Region for which it is responsible, including some municipal parks and private public spaces for which it has a management agreement. Management actions on invasive alien species are integrated within the ongoing management, or planned accordingly when a problematic occurrence is reported. In case IAS are observed during ongoing management actions by field workers, these are removed on an 'ad hoc' basis, usually with a follow up by the same team.

A wide range of invasive alien species are managed: plants (land plants, riparian plants and aquatic plants) and animals such as for example invasive aquatic birds and aquatic turtles. Management actions of IAS are documented on paper by the field managers (using a notebook), but are additionally encoded in a digital management recording tool (on computer or on the smartphone) since 2023 (iAsset tool developed for LIFE RIPARIAS project, see Part IV). There is a great interest within the team to further explore and finetune the digital registration of management actions in a central system that can be accessed by different actors in the field.

2.3. Contrat de rivière (CR)

In Wallonia, Contrat de rivière is contracted by waterway managers to observe IAS, evaluate and plan (prioritize) general management actions. If requested by a waterway manager, CR also manages IAS. Since 2023, CR is actively managing widespread and emerging plant IAS for the LIFE RIPARIAS project. These actions are registered in iAsset, the tool developed for LIFE RIPARIAS (Part IV).

Contrat de rivière is subdivided into multiple local organizations, depending on the river basin. Within the LIFE RIPARIAS project area, the following organizations of Contrats des Rivières are active: CR Senne, CR Dendre and CR Dyle.

CR Senne

CR Senne has been managing the following three species for over ten years: giant hogweed (*Heracleum mantegazzianum*), Himalayan balsam (*Impatiens glandulifera*) and floating pennywort (*Hydrocotyle ranunculoides*). There were attempts to also manage Japanese knotweed (*Reynoutria japonica*), but as these were not successful, it is no longer managed intensively.

Up to 2023, a form built with Fulcrum is used by CR SENNE in the field to record locations where a management action is required (i.e. solving erosion, fixing a bridge construction, waste water running into the river or removing an IAS). Based on these observations in the field, management actions are prioritized and evaluated. It is also a medium that is used to communicate with waterway managers as they have access to Fulcrum. However, it is not used for the registration of management actions. Details of management actions are written down in Word or Excel, linking to the location of an observation in the field. These details only encompass the management method (root out, pulled out manually, by machinery), management impact (number of plants removed) and management effort (how many persons and how long). Some details about the management action can be added to the comments field, but this option is limited and not consistently used. If a management action is completed, it is highlighted within the field 'follow-up' of a location which is then set to 'solved'. Evaluation of management actions is done by revisiting sites at regular intervals (yearly) and recording the most recent state within the evaluation field of that location. A large throwback of the field management system is that locations can only be defined as points and per location, and only one evaluation can be stored. As such, the history of evaluations at a location can not be traced. However, it is possible to record observations in remote locations as the app is also available offline. Entries in the app are immediately available online for those registered in the system.

CR Dendre

Also since 2010 (start of the regional management plan), IAS are managed by CR Dendre. Mainly Himalayan balsam (*Impatiens glandulifera*) and giant hogweed (*Heracleum mantegazzianum*) are managed within the Dendre river basin. In this organization, Fulcrum is also used to plan and evaluate management actions. However, field management actions are recorded in QGIS as this is not possible in the version of Fulcrum used by this CR. Per management action, a location (as polygon, line or point), species and date are saved in QGIS. No details regarding management method, impact, effort or non-target effects are collected. Data in QGIS can only be added on the desktop by the field manager and is not centrally available within the organization.

CR Dyle

CR Dyle manages Himalayan balsam (*Impatiens glandulifera*), giant hogweed (*Heracleum mantegazzianum*), floating pennywort (*Hydrocotyle ranunculoides*), parrot feather (*Myriophyllum aquaticum*), American skunk cabbage (*Lysichiton americanus*) and all species within the LIFE RIPARIAS target species list. No other invasive species are managed. All managed species are recorded either (i) as management actions in Fulcrum (for *Impatiens glandulifera*), (ii) as management actions in DEMNA portal (for *Heracleum mantegazzianum*) or (iii) as observations in DEMNA portal

(for other species on the LIFE RIPARIAS list). In case a management action is reported as an observation, only point location and species name are recorded. Since the start of LIFE RIPARIAS, extra management data have therefore been stored within a separate spreadsheet (using ANB format), as all LIFE RIPARIAS partners agree on collecting a minimal set of field management information for reporting. Before, no extra data was stored per management action. Importantly, not all observations on the DEMNA portal correspond to management actions, only a subset. All data on management (species name and location) are also stored offline on the desktop of the field manager in an ArcGIS project. This project contains three shapefiles, with one shapefile per taxonomic group (plant, vertebrate and invertebrates). Up to 2023, no concrete plans existed to automate the reporting of management actions. According to CR Dyle, a field management registration system should (i) take little time, (ii) be straight-forward and user-friendly and (iii) allow data export. There's no interest for a dedicated smartphone app, as smartphones or tablets are not used during field work and actions are not registered by the field workers, only by the field manager. Since 2023, CR Dyle has the option to use iAsset for the registration of management actions during the LIFE RIPARIAS project. Nevertheless, the platform remains unused by CR Dyle so far.

2.4. Department Integral Water Policy Service of the province – East Flanders (DIPW-EF)

The department Integral Water Policy Service of the province - East Flanders monitors since 2007 IAS which occur within watercourses and their banks (up to five meter distance) of second and third category (smaller rivers, brooks and streams). The department plans and evaluates management actions which are performed by Rato vzw. Rato vzw applies its own field management registration tool (see below). The department Integral Water Policy Service uses a QGIS project in which all data of IAS are visualized in different layers and that is centrally stored on the server of province East Flanders. The first layer contains observations of species, which are used to evaluate and prioritize management actions. These observations are collected in the field in notes and then transferred to a QGIS project when in the office. Other layers contain management actions for each invasive species or group e.g. aquatic plants, *Heracleum mantegazzianum*, cages for sliders etc. The long term management trajectory of invasive plant species is traceable, including information about the level of accessibility, difficulty of eradication (which is expressed in level of contamination), predicted costs (in case of fixed costs per species e.g. € x per m² for removing giant hogweed) and advised period of aftercare.

Two departments within the province – East Flanders (Nature and environment and Integral Water Policy Service) are planning to use gisib as field management registration tool for general management purposes (including management of invasive alien species within roadsides). Currently, this new field management registration tool is being tested within the provincial domain of Puyenbroeck for the purposes of general management of watercourses. In the future, observations and management actions of invasive alien species will also be synchronized with this tool so that the billing of management actions can be automated. Gisib is also very flexible in creating objects (points, lines or polygons) and assigning attributes.

2.5. Flanders Environment Agency (VMM)

Rat control team

Within the rat control team, the following invasive alien species are managed, which occur in or near the water surface: rats (*Rattus norvegicus*, *Myocastor coypus*, *Ondatra zibethicus*), three plant genera (*Hydrocotyle*, *Ludwigia*, *Myriophyllum*) and the Chinese mitten crab (*Eriocheir sinensis*). These species are managed by this team within a wide network of water bodies within Flanders (not only unnavigable watercourses of category 1).

The rattenapp was developed by VMM in 2016 and originally exclusively used within the rat control team. Both management actions and observations can be registered. Depending on the expertise of the field employee, observations of other (alien) species are registered and management may follow eventually. Locations are exclusively stored as points. Each location is assigned a unique id so that the history of actions per location can be traced. Management of plants is performed by hand picking, whereas the management of rats is done by trapping or by using rodenticides. In that case, the type of trap (i.e. conibear, ground clamp, fykes) or active substance (i.e. difenacoum or bromadiolone) and total quantity are registered. The result of a management action is also recorded (i.e. number of rats captured), weight and sex per captured rat, and possible bycatch. Management effort is not recorded as such within the app, although prospection points (registered in the app) can provide a proxy for management effort, as well as the amount of traps set. A possible improvement would be the inclusion of transects (in addition to point locations which are currently used).

Data are stored on a VMM server. Data entered by field staff on their rattenapp smartphone app are synchronized twice per day with the central database. No international data standards concerning methodology are adopted to report management actions. All data are openly available on GBIF, for example there is a Life MICA dataset that published captures of muskrat (*Ondatra zibethicus*) in Flanders between 1991 and 2018. Data are updated either annually (for plants) or weekly (for rats).

The department responsible for management of unnavigable, 1st category rivers

This division within VMM organizes general management of water bodies, among which the management of certain IAS (i.e. *Impatiens glandulifera* and *Heracleum mantegazzianum*) which occur on the riverbank. Invasive alien species in or near the waterbody are managed using contractors through public procurement (extensive infestations), or by colleagues from the rat control team (generally smaller infestations, but can be large as well). In some cases, follow-up management of cleared infestations is provided by the rat control team (and in this case, data on follow up will be available in the rattenapp dataset). This department limits management of species to unnavigable watercourses of category 1. Per management action, a contractor is employed to perform the management action. Most contracts only include a visual inspection in the field to see whether or not a management action was performed according to the standards (complete removal, biosafety procedures, ...). Registration of the management action within a field management registration system is not mandatory. Therefore, data on these management actions are scattered within the organization (in emails or within reports) and not centrally available. Central registration of management actions is a goal of the organization, and at the moment, iAsset is used for the registration of LIFE RIPARIAS management actions. After expiration of the project, both iAsset and Rattenapp are considered as viable options for central registration of management actions as these are already used within VMM (the former for other purposes than management registration). This recording tool should be user friendly enough so that field managers can easily submit all the performed management actions. The development of an app above a web application is therefore highly favoured. The minimum level of information per management action that should be recorded

is: location, species, date, history per location, price unit of management action (at project level per species) and method (manual/mechanical etc.).

2.6. De Vlaamse Waterweg nv

The Flemish Waterways authority manages and operates the waterways as a powerful network that is shaped by the economy, prosperity and quality of life in Flanders. DVW strengthens transport via inland shipping, ensures water management and increases the attractiveness of the waterways for recreation, tourism and nature experience. Management is restricted to dikes and navigable waterways. The management of aquatic plants started in 2016. Terrestrial plants have been managed for almost 20 years. Invasive plants which are being managed are *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum*, *Ludwigia grandiflora*, *Reynoutria japonica*, *Impatiens glandulifera* and *Heracleum mantegazzianum*. Also, there are some pilots for managing *Eriocheir sinensis* in collaboration with VMM.

Currently, the application iAsset is used to plan, monitor and evaluate general management actions by the Flemish waterways, but not yet invasive species. iAsset was initialized within the Flemish government by the Department of Mobility and Public Works. In the future, iAsset will be used by DVW and VMM to set up a management plan for invasive species. Currently, the green management working group is in the process of agreeing on a new registration standard (OTL) for [vegetation](#) that will be applied within the Flemish government to record and exchange data on the management of woody and grassy vegetation (including IAS). So far, there are no plans to extend iAsset with an OTL to register management actions on animals.

2.7. Rato vzw

Rato VZW is a non-profit organization working at both provincial and municipal levels. The following species are managed by Rato vzw: *Heracleum mantegazzianum*, *Ludwigia grandiflora*, *Ludwigia peploides*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum*, *Impatiens glandulifera*, *Ondatra zibethicus*, *Vespa velutina*, *Rattus rattus* and *Rattus norvegicus*, *Alopochen aegyptiaca*, *Branta canadensis*, *Anser anser domesticus*, *Anser anser*, *Neovison vison*, stray cats, chickens, moles and rabbits. Management is performed in those municipalities of East Flanders, which are assigned to Rato vzw and have representation in the governing board. As the registration system is essential for administrative reasons and planning, registration is mandatory for field employees and all management actions are recorded.

VertiGIS

Since 2021, Rato vzw uses a georeferenced field management registration tool built with VertiGIS studio to plan, register and evaluate all their field management. The advantage of this VertiGIS application is that it is used as a means of communication between the administrators and field workers of Rato vzw. Daily, field workers receive a list of actions that should be performed. When registering, the following information is collected: location, observation (confirmed, not confirmed or uncertain), action (cathod or removed, giving advice or determining control plan), material used (type of trap or fike) and future planning (finished, one more visit necessary, repeated visits required). Locations can be defined as points, lines or polygons. The method is subdivided in several categories:

mechanical removal, hand picking, trapping, manual removal, etc. (with a fixed vocabulary depending on species). Management impact is defined as the number of trapped/observed animals or %m² removal. In case of plant management, degree of re-infestation or regrowth can also be defined during a follow-up visit. The VertiGIS tool for Rato vzw also allows time registration of all field workers, at this moment it is only in use for management of plant trajectories. Moreover, reports can be generated with an overview of performed actions and required time per field worker. Reports are possible in different formats (excel, PDF, shapefile, etc.). The VertiGIS tool for Rato vzw is only available as a web application that can be accessed by mobile phone or desktop. RATO vzw can adapt most functionalities themselves (e.g. which screens are available for each species, buttons and filters or templates for registration). A disadvantage of this tool is that it is not (yet) available offline. Registered partners can also access the tool for entering observations after receiving a login. These observations need to be approved by Rato vzw before entering the database. The configuration, development of new functionalities, maintenance and licenses of the VertiGIS tool are expensive (> € 100,000). The data are stored on the server of Province of East-Flanders and are accessible by all the staff of Rato vzw. The data are immediately updated when an action is registered in the field. The data standard ISO-8601 is used for date and time, NIS codes are used to assign municipalities and GBIF codes are included for species. Data is available upon request and planned to be soon available on GBIF (as part of LIFE RIPARIAS action A1). In the future, the web application might be extended with a mobile application.

ECOSYSTEM

Before the VertiGIS app, Rato vzw recorded field management actions with the Ecosystem app which was developed within the Interreg project Ecosystems. This project was envisioned to improve muskrat population control at the Belgium-France border. This project started in 2017, in East and West Flanders (Belgium) as well as 'Département du Nord' (France). The development was based on the rattenapp of VMM (see below), who was also a partner of this project. This app is still used by some municipalities in East- and West-Flanders. The main target species are the muskrat, brown rat and Egyptian goose, but all Union list species (animals and plants) are also included, to allow complete reporting of all managed species.

When registering an action in the field, the following steps are taken: 1) verify whether to update an existing or create a new registration, 2) optimize GPS signal (ideally, the error is less than 15 m) and define location, 3) select the species domain, 4) select the species name, 5) select the type of action (observation or management action), 6) select the type of material, 7) add a picture or remark and 8) confirm the registration. Species domain determines the options that appear in later steps. Locations are limited to point locations in the mobile app. These can, however, be combined into lines or larger areas in the back office. The management method can be classified into the following categories: trapping, manual removal or chemical removal. Some methods can be defined further (for instance: the type of trap). Management impact is traced by recording the number of catches and active traps or number of plants removed. Management effort and non-target effects (i.e. bycatch) of management are not recorded. Unfortunately, management history can not be traced per location. To circumvent this, the number of individuals trapped during an action is always added up to the number already registered at that location so that the total sum of caught individuals is easily traced. Record history can be traced in the back office.

The app is developed in three languages (French, Dutch and English) and the code (in Java) is not open source, but available upon request for further development. Besides a web app, a smartphone app is available in Google play store. The app can also be used offline. When field executors enter a management action into the smartphone app, the data are immediately synchronized with a server on Google. The ecosystem app on the Google server is maintained by Continuum. The data standard ISO-8601 is used for date and time, NIS codes are used to assign municipalities and GBIF codes are included for species. Currently, the data are not openly published but will be published in the near future.

2.8. Regionaal Landschap Schelde-Durme

RLSD performs general management of small landscape features and landscape management (including IAS such as *Reynoutria japonica* or Bambuseae). They focus on 24 cities and municipalities along the Scheldt and Durme rivers. Since 2018, DIPLA (Digitaal Platform Landschapsbeheer) is used for management registration. Most management actions are registered within the tool. A detailed work plan is defined per location. Locations can be defined as polygons, lines or points. Management method is recorded (mechanical or handpicking). The level of occupancy (total surface covered) is traceable over time. Non-target effects are not registered by RLSD. Total person hours and material used can be registered by contractors. DIPLA is accessible by smartphone (MyDipla) and a web interface (DIPLA). Data is stored on the DIPLA server. Data entered in the field are almost immediately available on the server (depending on the network connection). The data are not compliant with international standards and are not openly available.

Recently, RLSD implemented the MyObs module from DIPLA to gather information about Japanese Knotweed through volunteer efforts. In this process, volunteers complete a questionnaire regarding a specific infestation. Based on their responses, DIPLA proposes an action plan for managing the infestation. The use of MyObs as a tool provides a promising framework for future, larger survey projects within RLSD and beyond.

Although DIPLA still has some limitations for data visualization, RLSD is very satisfied and not interested in using new systems. Profisi (the company behind DIPLA) is working closely with RLSD to find solutions for certain problems. Where necessary and possible, new features get developed

2.9. Wallonie Service Public (SPW - DEMNA)

Several invasive species are managed by SPW, such as *Vespa velutina* (through private contractors), invasive aquatic plants, *Ondatra zibethicus* (by rat catchers of the administration), *Branta canadensis*, *Impatiens glandulifera* (coordinated by contrats de rivière), etc. Only for *Heracleum mantegazzianum*, a species for which a general management plan was developed in Wallonia in 2011, a management registration system is used. Still, management actions for this single species are not always recorded. Managers will be more prone to register if a simple mobile app were available'. This system is available online (login required) and has been used in Wallonia since the regional management plan was initiated (2011). It was designed specifically for SPW and is not openly available. For each giant hogweed population, a registration file can be created that records the location (point locations), management method (root cutting, grazing, mechanically or defined more precisely (option for fill-in field)), size of population (number of individuals) before removal and proportion removed (%). Non-

target effects of management are not included. Management effort is recorded as total man days. Additionally, manager name, green waste outcome, evaluation at a later date and restoration of native vegetation can be saved per management action. If a population is not managed, the reason can also be indicated (open text field). The database of this management tool is stored on the SPW DEMNA server. Depending on the manager's response time for reporting, the typical time lag between actions in the field and data availability to the organization might take a few months. The organization is not satisfied with the application currently used and is interested in a new field management registration tool suggested by this business analysis.

Part II: The registration needs of field managers

The following aspects are considered necessary to be implemented for a field management registration tool:

- Ability to store the entire history of management actions per location
- Ability to add evaluation or visual inspection to a location
- User-friendliness and high accessibility
- Ability to work well on a smartphone
- Ability to export data as csv
- Flexibility in storing locations as polygons and lines, not only points
- Option to define projects with specific attributes

The following aspects were also considered useful by some partners:

- Integrate as many aspects as possible in one app (planning, evaluation, visualization)
- Have one app for multiple species (not different apps for different species)
- Record GPS position automatically
- Make offline registration possible
- Enable extended registration

Partners who showed interest in using a new tool were offered a second questionnaire that focused on their specific needs and prioritization. As such, the list with general needs was extended with the following items (see table A1 in appendix for details per partner):

- Planning tool
- Complementarity with own system
- Dedicated mobile app
- Data export to shapefile for visualization (in addition to csv)
- Possibility to extend registration per action
- Inclusion of LIFE RIPARIAS KPI

The complete list of necessary features were later grouped in the following categories:

- I need a mobile app (as opposed to a mobile website): Offline available, mobile app
- I need fast registration of management actions: User-friendly, registration takes little time
- I need extensive registration of management actions: Extended registration per action (effort, cost, methodology, etc), polygons (besides points), evaluation per action, possibility of adding evaluation and actions, possibility to register multiple actions per location
- I need admin access: Define projects and properties, planning (per month or yearly)
- I need access to the data: View history per location, export as csv
- I need other things: Complementary with own system, include LIFE RIPARIAS KPI

Each partner highlighted two to three features which they consider critical for the new tool to be used during the next field season (see table 7).

Table 7. Prioritization of features for LIFE RIPARIAS tool per partner

Feature	SPW	CR Dyle-Gette	CR Senne	VMM	BE
I need a mobile app (as opposed to a mobile website)	high priority				
I need fast registration of management actions	high priority	high priority		high priority	high priority
I need extensive registration of management actions				high priority	
I need admin access			high priority		
I need access to the data	high priority	high priority	high priority		high priority
I need other things	possibility to visualize data	Export option as shapefile included	Need discussion with others on this	Default fast registration with button to allow extensive registration if needed	

Part III: Available software for field management registration

1. Detailed description per software

1.1 AppSheet

[Google Appsheet](#) is a web app that allows users to quickly create apps with a wide range of purposes. It is possible to trace the history of a record over time. Both evaluations and actions can be added separately to a location. A mobile app is available allowing offline registration. Uploading pictures is also supported. The following export options are available: CSV, XLSX, Google Sheet, S3 bucket and SQL. Only points are supported. Subdividing observations into different projects is possible but not straightforward with a single button. Planning of management action can also be implemented. An API is available. The CORE costs US\$ 10 / user / month. The app is multilingual based on the language preference of the browser. Translation to other languages needs to be defined at setup.

This software is currently used by: none of the partners.

1.2 ArcGIS Field Maps

ArcGIS Field Maps is an all-in-one mobile app that is part of the integrated ArcGIS Platform. ArcGIS is available as a web solution (ArcGIS online or Enterprise) and desktop app (ArcGIS Pro). The history of management actions per location can be traced. Both evaluations and actions can be traced. ArcGIS Field Maps offers offline support. Also, pictures can be uploaded. Data are always synchronized and consultable in multiple included ArcGIS apps. Export format is highly flexible but should be defined at setup. Points, lines and polygons are supported. High accuracy data collection is supported. Projects with specific attributes can be created. Planning is supported. The system can be set up in any language, depending on language settings in the browser or phone. An API is available. Pricing is dependent on many factors (e.g. data stored on ArcGIS server or online, number of users). ArcGIS User Types are available for ArcGIS Online (cloud) and ArcGIS Enterprise (server) The commercial price is 750 euro per manager (Creator) and 560 euro per field employer (Mobile Worker). For ArcGIS Online, a Hub configuration is available costing 17,500 euro for 100 Creators and including 10,000 [ArcGIS Online credits](#). Purchasing these user rights gives access to all the ArcGIS web apps, including Field Maps. The Esri Enterprise Agreement for the Vlaamse Overheid contains partly these products at more interesting conditions.

This software is currently used by: none of the partners.

1.3 DIPLA

[DIPLA](#) is a web app to efficiently plan, register and follow up green space management. The history of management actions per location can be traced. Both evaluations and actions can be assigned to a location. A mobile app is available, offering minimum offline support (short loss of mobile connection is supported but not allowed to work offline for a long time as maps will not upload). Data

are exportable in PDF, XLXS, SHAPE and DOCX. Points, lines and polygons are supported. Projects with specific attributes can be created. Pictures can be uploaded. Planning is supported extensively. Web app and mobile app are available in Dutch. A WFS live connection is optionally available. The software costs € 6,300 per year for three projects (VAT not included). Additionally, at the start, a short training of 5 days is necessary costing € 800 per person. The software is available only in Dutch.

This software is currently used by: Regional Landscapes Schelde-Durme.

1.4 Ecosystem

The [Ecosystem web app](#) is specifically developed within the [Interreg](#) project [Ecosystems](#) which was envisioned to improve management of muskrat population control at the Belgium-France border. Unfortunately, management history can not be traced per location in the app. To circumvent this, the number of individuals trapped during an action is always added up to the number already registered at that location so that the total sum of caught individuals is easily traced. Record history can be traced in the back office. It is possible to also define evaluations besides management actions. A mobile app is available, allowing offline registration and uploading pictures. In the mobile app, only points can be created but in the back office, point data can be combined into lines or points and the history per registration can be checked. Data can be exported in the back office as PDF or CSV. Subdividing observations into different projects is possible but not straightforward with a single button. Planning of management actions is not supported. An API is available. The app is developed in three languages (French, Dutch and English) and the code (in Java) is not open source, but available upon request for further development. Based on the rattenapp of VMM, this tool was developed further and is currently hosted by [Continuum](#).

This software is currently used by: some municipalities in East- and West-Flanders (and previously Rato vzw).

1.5 Fulcrum

[Fulcrum](#) is a web app focussing on the automation of field inspection management. It allows the creation of customized forms. Full temporal tracking of data from the field is possible and can be viewed within the web management tool. Both evaluations and management actions can be assigned to a location. A mobile app is available, allowing offline registration and uploading pictures. Data can be exported in the following formats: text files (csv), shapefiles, File Geodatabase, Excel spreadsheets, SQLite databases, SpatiaLite, PostGIS/PostgreSQL. At this moment, only point locations are supported. Projects with attributes can easily be created. Of note, record linking and repeatable fields (Parent-Child records) are also supported. Fulcrum also supports the planning and scheduling of field management actions. The mobile app is supported in multiple languages among which English and French ([Dutch only supported for 11%](#)), whereas support and the web app are only available in English. An API is available. The professional mode costs US\$ 33 per user per month.

This software is currently used by: CR Senne, CR Denne, CR Dyle.

1.6 GBlbeheersysteem

[GBlbeheersysteem](#) is a web app designed by Antea Group to support management of public space. It is possible to trace the history of management actions per location and objects. Also, both

evaluations and actions can be assigned to a location. A mobile app is available which supports minimal data entry when offline. The GBI World application can be used on a tablet, laptop or phone. Pictures can not yet be uploaded within the mobile app, but it is currently being developed. Data can be exported in several formats, among which PDF and CSV. Besides points, lines and polygons are also supported. Projects with specific attributes can be defined. Planning options can be integrated. The web app and mobile app are supported in Dutch. At the start, a one time fee is charged which depending on requested features. Mostly this fee costs between € 10,000 - 15,000). Per year the application can cost between € 18,000 and € 25,000 (these are license and hosting costs). As the fair-use policy is applied, the price does not depend on the number of users. This is an approximation as exact costs depend on the number and type of modules that are implemented in the system.

This software is currently used by: none of the partners.

1.7 VertiGIS

[VertiGIS](#) Studio is a configuration toolbox to create workflows, planning and reporting systems on top of ESRI-technology. Management history per location can be traced. Both evaluations and actions can be recorded. Besides a web app, a mobile app is also possible, allowing offline registration and uploading pictures. Export options are very flexible (shapefile, CSV, XLSX, GLM, datatable, KLM) and can even be further extended by the user. Spatial data are supported in multiple formats: points, lines and polygons. Projects with attributes can easily be created. Extensive planning tools can also be implemented but may need an extra development and cost. Setup and development is always in English but the language of the web app and mobile app will depend on the settings of the browser (French and Dutch are supported). Licensing is available as a subscription model at costs starting at € 3,500 per year. The use of a ESRI-technology (ArcGIS server/ArcGIS Online) is a prerequisite to run this software. An API is available.

This software is currently used by: Rato vzw.

1.8 gisib

[Gisib](#) is a GIS-oriented application (desktop, online and API) to shape and support management of outdoor space. The history of management actions per location can be traced. An extensive inspection and planning module are available. Gisib desktop supports offline registration on tablet with changes needed to be manually uploaded when online. Data can be exported in the following formats: XLS, JPG, DXF, PDF, SHP and SUF. Lines and polygons are supported. Projects with specific attributes can be defined. Pictures can be uploaded. The system is only supported in Dutch. An API is available. The pricing varies highly depending on whether the software is used in-premise or SaaS. In case of SaaS for 25 users, the start-up costs € 29,000 and yearly costs are € 41,000.

This software is currently used by: Province East-Flanders.

1.9 Visma | iAsset

Visma | [iAsset](#) is a web app (Cloud / SaaS), offering complete support of management within the public space. The history of management actions can easily be traced. Both evaluations and actions can be assigned to a location. A mobile app is available allowing offline support and uploading pictures. By default, the following export options are supported: PDF, XLSX, CSV, JSON, XML, SHP,

HTML, GEOJSON. Points, lines, polygons, multi-lines and complex polygons are all supported, as well as the LAMBERT72 standard. The system is highly flexible in configuring projects and their attributes, but also inspections, reports and malfunctions can be registered. Data can be visualized on maps including smart queries and presenting layers. An extensive planning tool is also available. Further, a RESTful API is available. All information is accessible through the endpoint with default mappings to e.g. SafeFME, PowerBI, SAP. All GET/EDIT/DELETE/UPDATE requests are available on all instances, allowing middleware the full flexibility to make connections to iASSET and manage data through 3-tier parties. The app costs about € 12,500 as one time fee and € 12,500 per year for license costs, maintenance and support for 25 managers (access to web app) and 50 users (access to mobile app) and depending on the amount of objects that are registered within the system. Currently only Dutch and English are supported, but support for Swedish and French is being developed.

This software is currently used by: DVW. Since 2022: Contrats des Rivières, VMM, Brussels Environment

1.10 Magpi

[Magpi](#) supports data collection for a wide range of purposes, from activity reports, inspection checklists to in-field research. The entire history of management actions per location could be stored by using longitudinal data collection or parent-child records. Both evaluations and actions can be defined per location. Coordinates can be assigned to a survey and shown on a map. GPS is supported. A mobile app is available, allowing offline support and uploading pictures. Notably, only one-way communication from the mobile app to the web app is present. Therefore, a field employee only has access on his/her phone to the data that he/she collected him/herself. Export is possible within a wide variety of formats including text and Excel. Lines and polygons are not supported. Projects can be created, including a list of users that have access to it by creating different surveys. There are no limitations on the length of a survey, which might have implications for the performance of the app. A REST API is available. Five languages are supported (among which English and French) but surveys can be created in any language. The pro version costs US\$500 per month, including 6,000 uploads per year. There are no restrictions on the number of users. Magpi can be modified and will involve a conversation with our coders.

This software is currently used by: none of the partners.

1.11 REDCap

[REDCap](#) is a web app to build and manage online surveys and databases. Although it supports the collection of any type of data in any type of environment, the software has a strong focus on research studies and operations. The history of management actions can be traced in longitudinal data projects. Both evaluations and actions can be assigned to a location. A mobile app is available, allowing offline registration and uploading pictures. The following export options are available: Excel, PDF, SPSS, SAS, Stata, R. So far, only point data are supported. Projects with attributes can be created. Detailed planning options are available. A menu is available to select the preferred language (multi-language support). An API is available. Non-profit organizations within the REDCap consortium are not charged, if they have sufficient internal IT infrastructure to self-host.

This software is currently used by: none of the partners.

1.12 SurveyCTO

[SurveyCTO](#) is a mobile data collection platform (desktop app, web app and mobile app) with a strong focus on conducting interviews. In the SurveyCTO platform, it is possible to design and test surveys, collect data (offline, on the web, or via telephone surveys), monitor data (in near real-time), create simple visualizations, and export or publish data in other platforms. The history of management actions per location can be traced by case management. Both evaluations and actions can be assigned to a location by filling in different forms. The mobile app is also available offline. The following export options are supported: CSV, JSON, Stata, SPSS, Google maps, Excel, Word. Point data, lines and polygons are supported. Projects with specific attributes can be defined in multiple ways, depending on how these attributes are used (e.g. one survey per project). Audio fields from phone calls can also be uploaded, as well as photos. No planning tool is included. As multi-language support is provided, a menu is available to switch between languages. An API is available. The license costs US\$ 198 / month (unlimited users) for an annual subscription (after a 10% discount). When paying month-to-month, the price is \$220/month.

This software is currently used by: none of the partners.

1.13 Teamscope

[Teamscope](#) is a web and mobile app for research data collection. The platform offers a case management feature that allows the history of management actions per location to be easily organized by folders. Both evaluations and actions can be assigned to a GPS location. The mobile app for Android and iOS allows for offline registration and the uploading of pictures and videos. Data can be exported in CSV, TSV or XLSX. For location data, only points are supported. Although spatial data can be collected as points, they can not be visualized on a map. Projects can be created with fully customisable forms. Team members can be reminded with mobile notifications to take a certain action. The creation of fully custom reports with filters and sorting makes it easy to see segments of data. For instance, all entries can be selected where the last visit was more than 2 months ago or where a certain action was done. The interface is only supported in English but forms can be created in any language. An API is available. The pricing plans start at €199/month (Team plan).

This software is currently used by: none of the partners.

1.14 TenForce

[TenForce](#) is a cloud-based SaaS application accessible through a web browser. TenForce supports the planning and execution of (field and road) work, inspections and actions from intake to aftercare. Action management and tracking are integral parts of the application. Different types of actions, evaluations and workflows are supported and can be assigned to locations.

An audit trail keeps track of every change made in the application by any user through timestamps, ensuring history and accountability. A mobile app allows offline registration and the uploading of pictures. Data can be exported in many formats, among which CSV.

Polygons are currently supported if made available through a text field, which the application will then render on a map. The drawing of polygons will be available through the course of 2023.

Creating projects with specific attributes is highly flexible. Several languages are supported, including French, English and Dutch. An API is available. The one-time fee costs approximately € 19,000 for 20 man days. The yearly cost is € 9,000 for up to 500 users, including upgrades, hosting, support, maintenance and license fees.

This software is currently used by: ANB.

1.15 Wildnote

Wildnote is a technology platform specialized in environmental consulting that adds efficiencies to data collection, photo management, and formatting of reports for export.

The platform consists of the following primary components:

- A cloud-based database for storing data;
- A form-based data collection engine optimized for collecting data using a mobile app;
- A robust taxonomy framework for accurate and consistent data entry;
- A report generation engine for creating agency-ready and custom reports;
- A photo management engine for storing and exporting photos with associated data; and
- A project management interface for tracking issues, managing photos, monitoring workflows, making project assignments, and performing data QA/QC.

The platform includes a special location property which can be used to sort and filter surveys with data. The location property can be employed to trace the history of actions and evaluations.

A mobile app is available allowing offline registration and uploading pictures. The following export options are available: PDF, Word, Excel, KML, GDB, geoJSON, plus a variety of report builders to combine and summarize findings. Currently only point data is supported, lines and polygons are expected to be supported by the end of 2022. Projects with attributes can be created. Planning is supported. Menu of web app and mobile app are in English, but a survey can be in any language. An API is available. The software costs US\$ 625 / user / year.

2. Scoring software based on the needs of the partners

As highlighted in table 8, only four of the 15 apps currently check all the boxes of necessary requirements: ArcGIS Field maps, iAsset and VertiGIS. VertiGIS and ArcGIS Field maps are the only ones which are supported in English, French and Dutch. Notably, VertiGIS comes with the highest cost. All registration tools allow fast registration, also offline, and the export of data. Creating lines and polygons besides points is the least supported feature. A minimum complexity of planning support is available in most of the tools.

Table 8: Comparison between available registration tools based on the needs of the partners (see part II), language support and approximate costs.

Software	Mobile app	Fast registration	Extensive registration	Admin access	Access to the data	Language support	Approximate costs
Appsheet			Only points	Not easy to create projects		Multi-language support	€ 114 /user/ year (Core)
DIPLA	Offline connection only minimally supported (not able to upload maps)					Software support in Dutch, also French by end 2023.	€ 6300 for three projects (no VAT), € 800 training per person
Ecosystem			To be developed if needed	Not easy to create projects and planning not supported		French, English and Dutch	Potentially free (conditions negotiable with Rato vzw)
ArcGIS Field Maps						Many languages are supported, among which French, English and Dutch	€ 17,500 for 100 field managers (HUB) or €750 / year/ field manager (ArcGIS server)
Fulcrum			Only points			French and English	€ 377 / user / year (Professional)
GBIbeheersysteem			Not yet possible to upload pictures, but being developed			Dutch	One-time fee: € 12,500 + € 21,500 / year (unlimited users)
gisib	No. Gisib desktop supports offline registration on tablet, but no auth sync.					Dutch	In case of SaaS, the start-up costs € 29,000 and yearly costs are €41,000
iAsset						English and Dutch, French being developed	One-time fee: € 12,500 + € 12,500 / year (25 managers and 50 users)
Magpi	Only one-way communication		Only points	Planning not supported		English and French	€ 5,756.4 / year (max 6,000 uploads from mobile app)
REDCap			Only points			Multi-language support	Free for non-profit organizations having infrastructure to self-host
SurveyCTO				Planning not supported		Multi-language support	€ 2,259 / year (unlimited users)
Teamscope			Only points		Data not visualized on map	English	€2388/year for 7 users (Team plan)
TenForce			Polygons can be implemented when defined in text field, drawing supported in 2023			French, English and Dutch	One-time fee: € 19,000, yearly: € 9,000 (500 users)

Software	Mobile app	Fast registration	Extensive registration	Admin access	Access to the data	Language support	Approximate costs
VertiGIS						French, English and Dutch	One time fee: € 60,000 + € 10,000 / year
Wildnote			Only points, but lines/polygon support expected by end of 2022			English	€ 595 / user / year

The following software tools (partially) align with the specified technical requirements for the LIFE RIPARIAS project: ArcGIS field Maps, iAsset, SurveyCTO, Tenforce, Wildnote and Ecosystem.

The following software have too many missing features (that will not be developed in the near future) or no software support in English or French and Dutch. Therefore they are not advised to be used by all partners within the project:

- Appsheet: unlikely to adjust their roadmap and getting the missing feature
- DIPLA: the software is only supported in Dutch
- Fulcrum: lines/polygons are not yet supported and it is unclear when these will be developed
- GBibeheersysteem: too costly for the LIFE RIPARIAS project and only supported in Dutch
- gisib: no automatic synchronization of offline registered data, only supported in Dutch and too costly
- Magpi: Lines and polygons are not supported
- REDCap: we do not apply to their Use of Terms policy
- Teamscope: too many missing features

Part IV: Field management registration software for LIFE RIPARIAS

Based on the needs of the LIFE RIPARIAS partners (Part II) and the available software for the registration of management actions (Part III), we now identify the different scenarios for an optimized registration of management actions during the LIFE RIPARIAS project. For each scenario, we will describe the advantages and disadvantages. These solutions were discussed with the LIFE RIPARIAS partners in a participative workshop in August 2022. After carefully assessing each scenario together, one scenario was chosen for further development. This is discussed in the second part of this section.

Independent of the registration software that is used, registration of field management actions should be encouraged as much as possible. As highlighted in section 1.3 (part I), a high number of actions is not registered which represents a large bottleneck in the data flow of management information for reporting.

The following recommendations may help to stimulate field recording and are based on the experience of the questioned partners:

- Make registration mandatory, also for contractors.
- Provide smartphones to field employees so that ad-hoc actions can be reported immediately.
- Provide training for field employees so that they can recognize all IAS in the field and know the species that are being managed.
- Encourage field employees to use the app to manage locations and plan new actions.

1. Scenario's for optimized registration of management actions

From the partners involved in the LIFE RIPARIAS project, ANB is the only one that has expressed not to adopt any additional software for registering management actions throughout the project. Terraplan is tailored specifically to the needs of ANB and can therefore not be used by other LIFE RIPARIAS partners. So, using a single software adopted across all LIFE RIPARIAS partners is not a viable option. The other partners showed an interest for an (improved) registration system. We identified three scenarios (each scenario excludes ANB):

- One recommended, existing software for all interested LIFE RIPARIAS partners
- Each interested partner chooses an existing registration software, independently of other partners
- The development of a new, dedicated LIFE RIPARIAS field registration system for interested partners

One recommended software for all interested LIFE RIPARIAS partners

If all LIFE RIPARIAS partners who are interested in using a new registration system would use the same one, this would largely simplify the effort of combining all information for reporting purposes.

However, the field management data of ANB would need to be retrieved separately. This requires data harmonization before allowing any analysis or visualization on a dashboard (action D1 of LIFE RIPARIAS) (Figure 1). Potential software solutions for the other LIFE RIPARIAS partners include (see Part III, chapter 2): generic toolbox applications such as ArcGIS Field Maps, iAsset, SurveyCTO, Tenforce or Wildnote on the one hand, and the Ecosystem app on the other hand.

Using Ecosystem has the large advantage that a first version of the app is immediately applicable and available for each partner in the field in 2023. It was specifically designed for the Interreg project Ecosystem and thus tailored to the needs of the field managers. Additionally, the app has no license costs, although this should be negotiated with Rato vzw. As a result, LIFE RIPARIAS' budget could be fully invested in the extension of the current features so that a detailed registration, the creation of projects and a minimum planning tool are also included. As Ecosystem was developed and is currently being hosted by Continuum, this partner is in the ideal position to further extend the app. Due to the absence of license costs, a large advantage of this solution is that the After-LIFE costs are lower compared to the previous option.

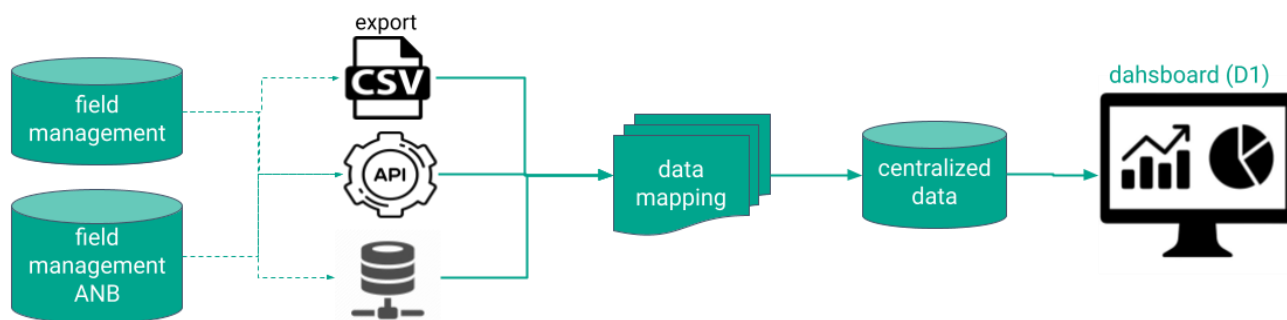


Figure 1: The workflow if all interested partners choose a similar software to register management actions. Data exported from this software and ANB's software are standardized by mapping to the data exchange format (see below). These data are then imported into the LIFE RIPARIAS D1 dashboard for visualization and analysis.

Each partner chooses an existing software, independently of the other partners

Another possible strategy is to recommend software tailored to the needs of each partner using different software and centralize the information. The main advantage of this approach is that it allows each partner to use their preferred software or continue using the software they are accustomed to. For CR, the preferred option in this scenario would be to use Fulcrum. However, the full potential of Fulcrum is not yet exploited by CR. Many of the improvements which were requested seem to be already available within Fulcrum but are not yet used by the partner. This might be due to recent improvement of the software or buying the cheapest package which does not offer all options. However, lines and polygons are not yet supported by Fulcrum and it is unclear when this will be available. For VMM, iAsset would be the most beneficial option as it is already being utilized there. Brussels Environment and DEMNA do not use an application yet.

This scenario implies that field management data harmonization will play a key role in the whole workflow. This solution is however likely to be very fragile in the long term. We therefore recommend limiting the number of adopted solutions.

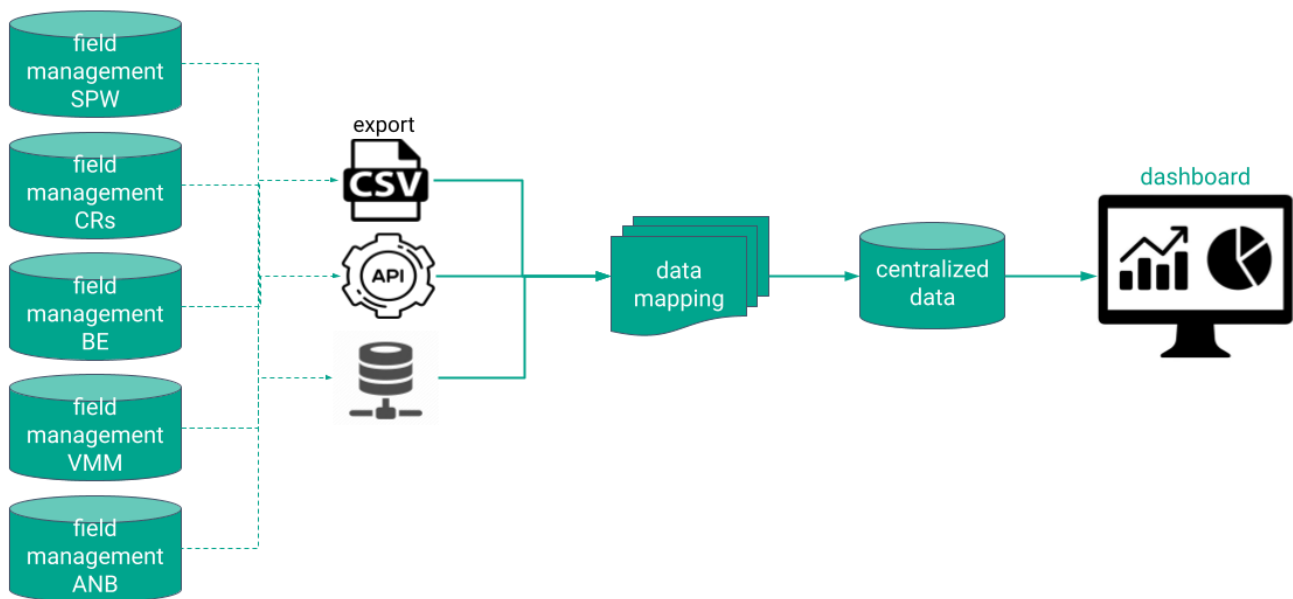


Figure 2: The workflow if all LIFE RIPARIAS partners use different software for field management registration. The harmonization of data collected by all these different software will be time consuming and challenging. Standardized data will be imported in the LIFE RIPARIAS D1 dashboard for visualization and analysis.

Develop a new LIFE RIPARIAS field management registration tool

Should a new field management registration tool be developed within the LIFE RIPARIAS project, full control over the development process would be maintained. Also, freedom in implementing tools will be maximally provided. A real-time and robust data flow can be assured. The final outcome will offer a simple and tight solution for management registration, with no unnecessary features included. However, developing a software tool fulfilling the needs of all partners is extremely time demanding. As it will not be possible to finish a first version of the software by the field season of 2023, an intermediate solution should be used. The developmental process will depend on the prioritization of the requested features by the partners (see overview of highest priorities in table 7).

2. iAsset as a field management software for LIFE RIPARIAS

In August 2022, we organized a [participative workshop](#) to assess the proposed scenario's together with the LIFE RIPARIAS partners. It was deemed most interesting to opt for one recommended software solution for all interested LIFE RIPARIAS partners. Two options were suggested: the use of Ecosystem or the use of one of the generic toolbox apps (iAsset, Tenforce, FieldMaps).

All partners agreed to opt for one of the toolbox apps, since they allow:

- **Self-reliance:** we can update and customize forms ourselves
- **Fast implementation:** changes made to forms are available immediately to all users
- **High flexibility:** different forms and fields can be created for different protocols
- **Simplicity:** it is possible to create simple forms (as well as more complex ones)
- **Multiple platforms:** the app is available on Android and iOS devices

Such a toolbox fits better with the requirements of the RIPARIAS project. A public procurement was sent out in September 2022. iAsset was the successful applicant for the public procurement for this

tool. It was introduced to the following LIFE RIPARIAS partners: SPW-DEMNA, CR, VMM, BE and INBO. Data from partners using other applications will be harvested and harmonized to allow data aggregation. All involved partners contributed input to customize iAsset according to their particular requirements, which has led to the field management registration form in Figure 3. By March 2023, an initial version of the tool had been developed and tested by these partners. EV INBO facilitated individual training sessions with each partner to familiarize field workers with the application, which was subsequently put into use.

General	
Registered by:	ireyserhove
Date/time event:	2024-04-11 10:44:28
GPS:	
External manag...	<input checked="" type="radio"/> Nee <input type="radio"/> Ja
Detail	
Species group:	Crayfish
Species:	Cherax destructor
Activity:	intervention
Intervention:	<input type="text" value="manual removal"/>
Quantity:	3,00
Other interventi...	<input type="text"/>
Unit:	individuals
Scale (add unit):	<input type="text"/>
Comments:	<input type="text"/>
Crayfish	
# traps checked:	5
Welfare status:	<input type="text" value="dead"/>
By-catch:	yes
By-catch species:	<input type="text"/>
Images	
Image 1:	<input type="button" value="Selecteer"/>
Image 2:	<input type="button" value="Selecteer"/>
Image 3:	<input type="button" value="Selecteer"/>
Image 4:	<input type="button" value="Selecteer"/>
Image 5:	<input type="button" value="Selecteer"/>
Working hours	
Time (hours):	<input type="text"/>
# employees:	<input type="text"/>
Total time:	<input type="text"/>

Figure 3: Field management registration form in iAsset.

3. Further steps

As described in the previous chapter, data harmonization is an essential step of any proposed workflow. Although the Darwin Core standard can be used to standardize management data to some degree, it does not capture all essential information to report on management actions. For this reason, the development of a data exchange format for IAS and wildlife management data has already started. This data exchange format is called manIAS (“management of Invasive Alien Species”) and was drafted in two consecutive workshops (Oldoni et al. 2022). The results of this workshop will be used to as a starting point to set up a task group for the Biodiversity Information Standards Organization (TDWG). The development of this standard is, however, a long-term process with multiple future refinements. In the long term, this data exchange format should be ratified by TDWG so that it can be advocated as a data standard for management within the IAS community.

APPENDIX

Table A.1: Required and optional features suggested by partners.

	SPW	VMM	BE	CR
Evaluation per action	Necessary	Necessary	-	Necessary
Extended reporting per action (effort, cost, methodology, etc)	Necessary	Necessary	-	Necessary (CR Dendre)
Mobile app	Necessary	Nice to have	-	Necessary
Include LIFE RIPARIAS KPI	Nice to have	-	-	Nice to have
Registration history	Necessary	Necessary	-	Necessary
User-friendly	Necessary	Preferably	Necessary	Necessary
Web app or desktop app	Necessary	Necessary	Necessary	Necessary (CR Dyle)
Export as csv	Necessary	Necessary	-	Necessary
Polygons (besides points)	Necessary	Nice to have	Necessary	Necessary
Define projects and properties	Necessary	Necessary	-	Necessary
Mobile app	Necessary	Nice to have	-	Necessary (CR Senne)
Available offline	Necessary	Nice to have	-	Necessary
Planning (per month or yearly)	-	-	-	Necessary
Complementary with own system	-	-	Necessary (e.g. Lambert projection)	Necessary
Low technical requirements	-	-	Necessary (no smartphone available)	CR Dyle (no smartphone available)
Registration takes little time	-	-	-	Necessary

